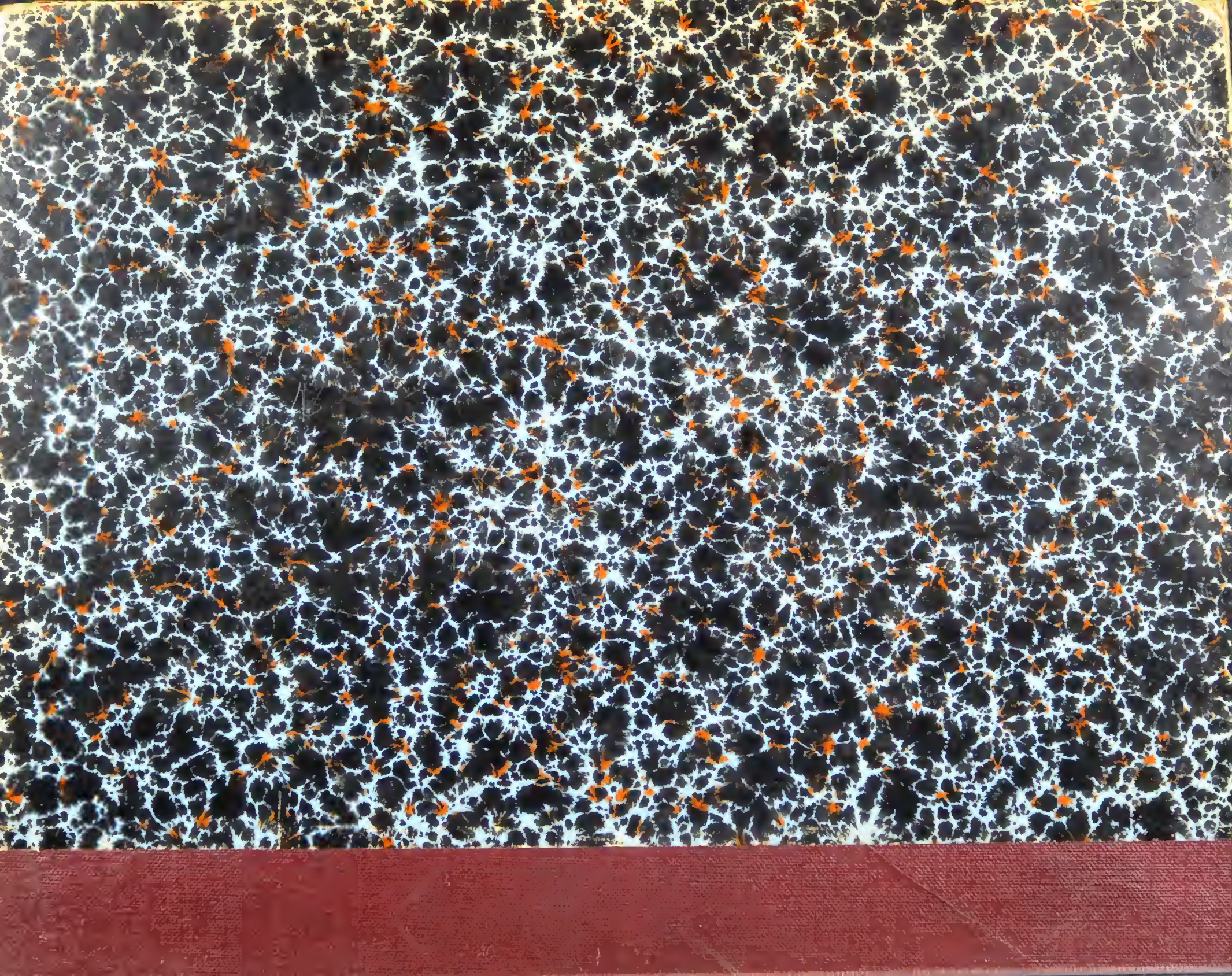

AN

ESSAY

ON THE

STRUCTURE AND MECHANISM

OF THE

TONGUE OF THE CHAMELEON.

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On the Structure and Mechanism of the Tongue of the Chameleon.—*By* John Houston, Esq., *Member of the Royal College of Surgeons in Ireland, Conservator of the Museum, and Demonstrator of Anatomy in the School of Surgery, &c.—Communicated by the Lord Bishop of Cloyne.*

Read April 28, 1828.

THAT the Chameleon possesses the power of suddenly darting out its tongue in a remarkable manner, for the purpose of seizing the insects on which it feeds, is a fact which has been long admitted; but notwithstanding that so singular a phenomenon has attracted the attention of the most distinguished anatomists, it appears to me that neither the cause, nor mode of elongation in the organ, have ever yet been satisfactorily explained.

Two of these animals having been lately presented to me, in sufficient health to take food in their natural way, an opportunity, such as rarely occurs, was afforded me, both of observing their tongues in the act of elongation during life, and of making a most satisfactory examination of their structure immediately after death. I therefore entertain a hope that the facts which I have collected, under such favourable circumstances, may be calculated to remove much of the obscurity in which the subject has been hitherto involved.

The animals were brought from Malaga in the month of October 1826. They corresponded in characters to the Lacerta Chameleon of Linnæus. One measured twelve inches in length, the tail included, the other ten. Both were females, and contained numerous ova, which could be felt through the thin parietes of the

abdomen. One of them while in my possession discharged, apparently with much labour, two eggs which were of an oval form, about the size of a wren's, and covered with thin yellowish coriaceous shells.

The external surface of their skin was thickly set with soft tubercles, like the heads of small nails, some of a whitish, others of a bright yellow colour: the white tubercles were most numerous, and existed every where over the body; the yellow ones were so arranged as to form along each side of the back two rows of lozenge-shaped spots, and round the legs and tail annular bands. When examined in the morning, or during sleep, the whole surface presented a greyish cast, with the exception of the yellow marks; but when the animal was excited in any way, as by pricking, or transferring it from a cold to a warm temperature, an evident change of colour took place, sometimes all over the surface, sometimes only partially, according as the excitement affected the entire or only a part of its body. A brownish tinge gradually overspread it, engaging equally the tubercles and the intermediate skin; while the spots, which were previously yellow, acquired a slight admixture of green. The shades, however, were few, and confined to those intermediate between a light grey and a deep brown, with a little yellow or green interspersed through them, but never, that I could observe, bore any relation to the colour of the surface on which the animal happened to be placed. In dissecting the skin after death, its exceeding thinness and vascularity attracted my attention. In every part, but more especially between the tubercles, it was so thin as to be almost transparent: and its internal surface, when examined through a magnifying glass, presented a complete net-work of fine vessels, rendered visible by the dark blood which they contained. A portion of skin removed from about the eyes, where

in death it became dark, even to blackness, displayed most satisfactorily the great abundance of its vessels.

These observations on the skin I have deemed it right to make, as they appear to confirm the opinion entertained by some physiologists, that its changes in colour are produced by vascular turgescence, just as the increased redness in blushing is caused by a rush of blood to the cheeks. The colour of the blood appearing through the semitransparent skin, and modified by the various permanent colours of that structure, is sufficient to account for every diversity of tint which the chameleon exhibits. I have been induced more particularly to offer these remarks in this place, because from the facts which I have noticed regarding its tongue I have been led to infer, that the peculiarities of that organ are all referrible to the same general cause, viz. vascular turgescence.

By keeping my chameleons in an equable temperature of about summer heat, I succeeded in preserving them both alive for upwards of two months, during which I had ample opportunities of observing the action of their tongues in the prehension of the insects on which they fed almost daily.

When a fly so maimed as not to be able to escape, but still sufficiently vigorous to move its legs or wings, was so placed that its fluttering might attract the chameleon's attention, the animal advanced slowly until within tongue's reach of it, then steadying itself like a pointer, sometimes stretching out its tail, sometimes fixing it against an adjacent body, and directing both eyes steadfastly on the prey, it slowly opened its mouth, and suddenly darted forth its tongue, which advancing in a straight line, seldom failed of striking with its glutinous cupped extremity the object aimed at. But even when the point happened to err, the prey did not always escape, being, nevertheless, sometimes secured by a similar adhesive matter

which coated the sides. The tongue then retired, thus laden, into the mouth, though somewhat more tardily than in its advance; and whenever the elongation had been considerable its extremity was bent a little downwards, giving to the organ a slightly curved appearance. When projected the tongue acquired a thickness equal to the largest swan's quill, and a length not less sometimes than six or seven inches. Its consistence I attempted, on one occasion, to ascertain, by catching it between my fingers, when it imparted the feel of an elastic body, yielding slightly when pressed on, and springing back instantly to its former state as soon as the pressure was removed. The experiment caused only a short delay to its progress, but neither altered its form or course, nor unfastened the prey from its extremity. Its colour along the centre was a dark livid; and each side, to within about an inch of the extremity, presented a whitish band, which during the act of elongation was straight and uniform, but in the retraction of the organ became evidently tortuous and wrinkled; while the whole surface, both centre and sides, was irregularly streaked with innumerable very minute blood-vessels. Near the extremity, a few veins much larger than the others, and having a longitudinal course, were in the highest state of turgescence.

It seems probable that the tongue is the sole agent assigned to the chameleon for obtaining its sustenance. Flies have often rested on every part of its body, and though it has looked wistfully at them, it had no means of apprehending its annoyers. I have frequently observed them for a considerable time on its very lips without any attempt being made at their seizure. Even when placed before it, if not sufficiently distant to afford room for the necessary evolution of its tongue, the chameleon was under the necessity of retiring, or raising back its head for the purpose.

It would appear to possess the power of regulating the force of propulsion of its tongue according to the distance of the prey; for when the latter lay near to the mouth, the organ advanced on it slowly; when farther off its velocity was more marked; and whether nearer or more remote it invariably darted with greatest quickness as its point approached the object.

The chameleon, when vigorous in its natural climate, is said to shoot forth its tongue with a velocity equalling that of an arrow shot from a bow;* but mine, weakened by long confinement and want of food, had become incapable of such activity—a circumstance favourable to my purposes—as by the prolonged exposure of the tongue, which occupied about five or six seconds, an opportunity was gained for making observations on its condition while protruded. I have several times mechanically detained it in view, by placing the fly to be aimed at, in such a position on a flat surface that the tongue might strike it in a direction perpendicular to that surface, under which circumstances its glutinous cupped extremity adhered like a sucker, and held the organ exposed for nearly double the ordinary period. Attempts at seizing insects similarly placed on the side of the animal's case, which was made of paper, gave it particular embarrassment, not so much from the delay caused by the adhesion, as from the annoyance which the down of the paper sticking to the mucus on the extremity of its tongue seemed to produce. Indeed it appeared to dread the inconvenience which resulted from striking at objects under these circumstances, as it always endeavoured to take aim in such a direction that the end of its tongue might escape a little beyond them without danger of interruption. On one occasion, when both animals attempted at the

* See Belon—Observations, &c. liv. 2. ch. 34.

same moment to catch a fly placed nearly midway between them, their tongues struck against each other, and held them connected for a short time.

It has been observed by naturalists, that the chameleon requires hours to accomplish the eating of a fly, but from having seen each of those in my possession swallow six or eight within the space of one hour, I can so far testify that the observation is incorrect.

To understand the motions of the chameleon's tongue it is necessary to possess a clear knowledge of all its parts; I shall therefore give, first, the anatomy of the os hyoides and muscles, and secondly, that of the moveable portion of the organ.

The os hyoides is unconnected with the larynx. It consists of a body and four cornua, two of which are anterior, and two posterior. (Plate, fig. 1st.) The body is prolonged forwards into a process named the style (A), which is rounded and smooth, and about an inch and a half in length, and whose point, when the mouth is closed, rests against the back part of the chin. The anterior cornua (BB) are about three quarters of an inch long: their outer extremities, which are cartilaginous and pointed, are directed obliquely forwards. Their inner extremities are articulated with the body of the bone, and a small plate of cartilage stands out from each, which serves as a pully for one of the muscles of the tongue, the hyoglossus. The posterior cornua (CC) are about the same length, and slightly curved upwards. One end of each is attached to the body by a moveable joint, the other passes round towards the back of the occiput.

The muscles are nine in number on each side. Three connect the os hyoides to the thorax, the sterno-hyoid, the sterno-ceratoid, and the omo-hyoid. Five extend from the os hyoides to the lower jaw, viz. the mylo-hyoid, genio-hyoid,, together with three which

may be called cerato-hyoid, and distinguished by the names external, middle, and internal. The ninth is a remarkable muscle, the hyo-glossus.

1st. The *sterno-hyoid,* (Fig. 2. a) a strong muscle, is attached by its posterior extremity to the lower and back of the sternum, and by its anterior one to the body of the os hyoides.

2d. The *sterno-ceratoid,* (b) at its origin from the sternum, is partly concealed by that of sterno-hyoid. It runs forwards and outwards, and is inserted into the outer extremity of the posterior cornu of the os-hyoides.

3d. The *omo-hyoid* (c) is long and slender, and interrupted about its centre by a short tendon. It proceeds from the scapula to the middle of the os-hyoides, passing in its course along the inner side of the sterno-ceratoid. These three muscles serve the office of drawing back the os-hyoides and tongue.

4th. The *mylo-hyoid** is a superficial muscle. It arises from the whole length of the ramus of the lower jaw, and from the skin along side of the neck, and running thence inwards, joins its fellow of the other side, underneath the os-hyoides. It supports the parts contained in the mouth and throat, while at rest, and while performing the complicated actions of prehension and mastication of insects.

5th. The *genio-hyoid* consists of two parts; one internal, slender (d) arises a little to one side of the symphysis of the lower jaw, and is inserted into the posterior part of the body of the os-hyoides. The other (e) somewhat more external, is larger and stronger, and inserted into the whole length of the posterior cornu. A part of

* This muscle I have deemed it unnecessary to delineate. I have retained the name previously given to it, though I could not discover any attachment between it and the os-hyoides. It might, I think, be better named platisma myoides.

its external border bends inwards to be attached to the anterior cornu.

6th. The *external cerato-maxillary* (f) arises from the posterior part of the ramus of the lower jaw, and becoming broader, is inserted into the anterior cornu of the os-hyoides.

7th. The *middle cerato-maxillary* (g) is narrow, and in part concealed by the external. It extends from near the centre of the ramus of the lower jaw straight backwards to be attached to the outer extremity of the posterior cornu of the os-hyoides.

8th. The *internal cerato maxillary* is long and slender (Fig. 1st, 2d, 6th, h), and situated deep on the mucous membrane of the mouth. It arises from the anterior part of the side of the lower jaw, and passing thence backwards on the upper surface of the style and muscles, ends in a tendon, which after uniting with its fellow of the other side about two lines before the articulation of the cornu with the body of the os hyoides, (Fig. 1st. h) becomes broad, and is inserted into the roots of the posterior cornua. The last four muscles, by contracting, will draw forwards the os hyoides, and protrude the end of its style a short distance out of the mouth.

9th. The *hyo-glossus* (Fig. 4. 6. iiii.) arises from the outer extremity of the posterior cornu of the os-hyoides. At first it accompanies the cornu inwards to near the body, then leaves it, winds round the cartilaginous pully on the anterior cornu, runs forwards along the sides of the style and erectile portion of the tongue, and is inserted into the anterior prehensile portion. This muscle admits of remarkable elongation, as its extremities, which are not more than an inch apart while the tongue rests in the mouth, become separated during its complete protrusion to a distance of five or six inches. It can only exert an action on the prehensile portion of the organ, which it retracts into the mouth after having been protruded

in the search for insects, and which it may settle and keep steady when so retracted.

The moveable portion of the tongue consists of two parts, which are distinct from each other both in their structure and functions. One of them I propose to name *prehensile,* the other *erectile.*

The first, or *prehensile* portion, is anterior (Fig. 2, 3, 4, 7, E.) It is somewhat cylindrical, about one inch and a quarter in length, and an inch in circumference. Its bulk undergoes no change during the elongation or retraction of the tongue, in consequence of its being surrounded by a dense fibrous sheath, which prevents any such alteration. Its anterior extremity is hollowed into a pouch lined with mucous membrane, (Fig. 3, 4, 5, F) which is rugose, and smeared with a viscid adhesive matter for entangling the insects it strikes against. During the projection of the tongue the lips of this pouch are everted so as to expand considerably its surface. Its posterior extremity is smaller than the anterior, and continuous with the erectile portion. The anterior half of its superior surface is occupied by an oblong glandular body (G), from which perhaps is secreted the glutinous coating of its extremity. The openings of this gland are on its lower surface, next the pouch, on which it rests. (Fig. 5, m) On the posterior half of this surface the ramifications of large blood-vessels are observable. Along its sides, posteriorly, the insertions of the hyo-glossi muscle present themselves. Its inferior surface is smooth and rounded. A tube (Fig. 5, p. p.) about the thickness of a small crow's-quill runs through its centre. This tube is prolonged into it from the erectile portion, and serves as a resting place for the style of the os hyoides, which it surrounds like a sheath, when the tongue is drawn into the mouth. It is encircled by an annular muscle, (Fig. 5, o. o.) the fibres of which are very numerous and strong, and have but a loose connection with the

tube. This muscle may, by contracting round the tube when it rests on the style, prevent its revolving on that bone, and thereby make steady the prehensile portion, and adapt it for the ordinary uses of the tongue in mastication. Two retractor muscles (Fig. 5. l.l.) arise one from either side of the back part of the annular muscle, and thence pass to its upper surface, where they meet under the mucous gland, to be inserted into the bottom of the pouch. They may contribute to the more effectual security of the prey by deepening, and closing the pouch upon it, a change which this part evidently undergoes while the organ is retiring into the mouth.

To the second portion of the tongue I have given the name *erectile*, on account of the resemblance which I conceive it bears to the other erectile structures of animals. It is placed between the prehensile portion and the os hyoides, and exhibits remarkable changes in bulk under different circumstances. When drawn from the mouth after death, which it may to the length of five or six inches, (Fig. 4. H) it presents itself as a slender chord, so flexible and soft as scarcely to be felt when caught between the fingers, and to appear little adapted for the purposes to which it is applied. During life, while the tongue rests in the mouth, this portion occupies an exceedingly small space, (Fig. 2, 7, H.) but when projected in the pursuit of insects it becomes greatly increased in dimensions (Fig. 3, H), and appears to be wholly the seat of that change which the organ undergoes in its elongation. Its structure is complex and peculiar. A fine transparent mucous membrane, which is continuous posteriorly with that which lines the mouth and throat, and anteriorly passes over the prehensile portion, encircles it on all sides. The hyo glossi muscles occupy its lateral surfaces. They are round and thick posteriorly at their origin from the os-hyoides, and become thin and flat as they advance forwards

to their insertion into the prehensile portion. Their pale fibres are rendered evident by a dark vascular net work which is placed underneath them. Through the centre of the erectile portion runs a tube, (Fig. 5, p.p.) which is attached behind to the style, and in front is continuous with a similar structure already described in the prehensile portion. It is soft, whitish, and homogeneous, of uniform size throughout, and remarkably extensible. When the tongue is quiet in the mouth, the tube lies folded on the style; when advanced, it is drawn off and elongated. It follows all the motions of the organ, gliding with it alternately off and on the style, which is rounded and smooth for the purpose; but it cannot, as some have supposed, take any part in causing the propulsion or retraction of the tongue. A highly vascular structure exists between this tube and the encircling mucous membrane. (Fig. 3, 4, 5, n.n.) It extends from the root of the style to the very end of the tongue, surrounding the tube equally on all sides. Its vessels, which are rendered visible even to the naked eye by their dark blood, appear, when examined with a magnifying glass, like a beautiful trellis-work, the branches crossing and anastomosing with each other to incalculable minuteness. A coloured spot, which resembles a mere stain, exhibits through a glass a congeries of vessels. This vascular appearance has been described by the anatomists of the French Academy in the following words: La membrane estait "couvert de taches tout du long comme si elle avoit esté imbuë en "dedans d'un sang noìrastre, extravasé et inegalement amassé en "plusieurs endroits." In another passage: "La Langue estoit "semée de quantité de vaisseaux apparens a cause du sang qui y "estoit en grand abondance, ainsi que dans tout le reste du corps." But the circumstance is noticed by them only to excite our astonishment, "que Aristote ait dit que la chameleon n'a du sang q'autour

du cœur, e des Yeux, e que la plus part des modernes le mettent au rang des animaux qui ont peu de sang."*

The lingual *arteries*, which are derived from the carotids, are of considerable magnitude (Fig. 2, 6, z.) They run before the posterior cornua of the os hyoides as single trunks, and are soon subdivided into numerous small branches which ramify through the erectile portion. Coagula of blood, together with the tortuosity of the vessels, prevented the ingress of injection to their minute terminations, though it passed sufficiently far, to show their general course and distribution.

Two large *veins* (Fig. 5, 6, x), which take their origin round about the prehensile and erectile portions of the tongue, run along its lower surface, and having arrived at the os-hyoides, where they are very conspicuous, one passes on either side of the root of the style, between it and the hyo-glossus muscle ; then it escapes between the anterior and posterior cornua, and applies itself on the side of the trachea (L). It next courses along the trachea, first overlapped by the thyroid gland (r), then by the carotid artery (y) and aorta (u), and at length opens into a large sinus (v) connected with the corresponding auricle of the heart (t), by an orifice which is distinct from that of the jugular vein, and a little to its inner side. I have succeeded in injecting the lingual veins with quicksilver through a pipe introduced where they lie on the trachea, and when distended with this fluid they acquired a size fully equal to that given them in the plate. The quicksilver ran into the tongue, and filling many of the larger branches, produced an evident turgescence in the most dependent part of the organ ; but the delicate vessels being unable to support the increasing weight of fluid, it soon becomes extravasated: sufficient however remained to show in a preparation the

* See Mem. de l'Academie Royale des Sciences, T. 3me. 1re. partie, page 46.

extremely vascular nature of the organ.—I am happy in being also able to adduce, in evidence of the fact, the names of Professors Jacob and Harrison, who witnessed the recent injection of the vessels, and who can bear testimony to their magnitude and numbers.

The exact mode of termination of the ultimate vessels in the tongue may not be easily ascertained, but from the extremely fine ramifications which are perceptible in it, I am inclined to think that it is by a congeries of vessels, the termination of arteries and commencement of veins, without the intervention of a spongy or cavernous texture.* And if this were established it would, in my opinion, afford a still farther confirmation of the analogy between the erectile portion of the chameleon's tongue and the corpus cavernosum, for that the latter is purely a vascular body, without any intermediate cells between its arteries and veins, many experiments and observations have satisfied me.

The heart in the chameleon consists of one ventricle (Fig. 6, s.) and two auricles (t.t) with each of which is connected a large sinus (v.) for receiving the blood of the body and tongue.—This remarkable cavity between the veins and auricles has never, that I am aware of, been before noticed in this animal. The French Academicians have described the auricles as being large, and the left in the chameleon which they dissected was the more capacious: but they have made no allusion to distinct sinuses apart from the auricles. In both those which I examined these sinuses were well marked; the right, however, exceeded by one half in magnitude the left, and formed a larger cavity than both the auricles taken

* The minuteness of the globules of the blood in this animal, which renders it highly diffuseable, appears particularly favourable for making observations on the magnitude of its ultimate vessels; for with a glass one could discover vessels tinged with the coloured parts of the blood, which were not visible to the naked eye.

together. It extended the whole length of the chest (Fig. 6, v.) from the superior aperture to the liver, and was not less when distended than two lines in diameter. Both were filled with coagulated blood; and the texture of their coats appeared the same as that of the veins which emptied into them. Their use may probably be connected with the varying condition of the circulation in the skin and the erectile portion of the tongue, on which I conceive depend all the phenomena for which these two parts have gained such notoriety. They may serve as reservoirs for the blood, when suddenly abstracted from either of them, previous to its readmission into the heart.

After this detailed description of the structure of the chameleon's tongue, we may be enabled to estimate the applicability of the several theories, which have from time to time been advanced, to account for its peculiar powers of motion.

It was denied by Marmol, who examined many chameleons for the purpose of clearing up this point, that their tongue had any such powers at all. He assures us that it is never exercised as a trap for insects, and that any thing which he had observed of the animal would not induce him to change his opinion, that air and the sun's rays are its only nutriment.*

M. Perrault attributed the elongation to an expiratory effort of the animal which darted its tongue from its mouth, " comme si il la crachoit avec violence."† The great size of the lung he supposed was for the purpose of effecting this movement. But there is no circumstance connected with the anatomy of the organ, or its mode of advancement, to countenance this explanation. Besides, the chest during the act, in place of evincing the motions attendant on

* See Mem. de l'Acad. Roy. des Scienc. T. 3. 1re. partie, p. 47.

† Ibid. T. 9, page 156.

an effort of expiration, remains dilated and immoveable: respiration for the moment appears to be suspended.

M. De la Hire suggested that perhaps the state of rest of the tongue is that in which it exists when elongated, and in which it is kept by some tendons so attached on a zig-zag form to the outside of the tongue (Fig. 8, B,A) as to act after the manner of a spring; and that its retraction into the mouth might be effected by the action of a longitudinal muscle (C,C). M. De la Hire offers a sufficient apology for so absurd a supposition, in acknowledging that he had never an opportunity of examining the structure of the organ.

The central tube was described by the anatomists of the French Academy as being a nerve which had the power of throwing forth the tongue (meaning the prehensile portion) which was attached to it, by elongation itself, and of drawing it back again by contracting. It is a sufficient reply to this explanation, that the part alluded to is not a nerve; and even granting it were so, that nervous structure is no where possessed of powers of elongation and contraction.

There is a common supposition that the tongue is extended by inflation with air, and drawn back again by the supposed nerve in its middle, which after having been elongated by the effort, returns it again suddenly to its former state. But this explanation is as untenable as the others, for no opening of communication can be discovered between the mouth or trachea and the tongue, through which air could find admission into the organ.

The Baron Cuvier, who has contributed so much to the advancement of natural science, supposes that the propulsion of the organ from the mouth, and its subsequent retraction, are effected in part by the alternate elongation and shortening of that portion which I have named prehensile, and in part by the advancement and retreat of the os hyoides. The entire process, according to his explanation, is

the result of muscular action. With regard to the elongation or shortening of its prehensile portion, which he conceives may be produced by the annular and retractor muscles,* a reference to my account of its structure will show that no such change in its form can take place. A dense, fibrous, inelastic sheath which surrounds it must effectually prevent an alteration being made either in its length or thickness by any muscular force which it possesses. Even when removed from the body, attempts to stretch it with the fingers are unavailing. Its cupped extremity admits of being spread out a little, but neither before nor after death can its form or bulk undergo any greater change. The protrusion of the style of the os hyoides from the mouth will be found, on studying its form and connections, an equally inefficient cause. The Baron compares this part of the process to that accomplished by the tongue of the woodpecker. He says†, "Il peut s'alonger considérablement par un méchanisme analogue à celui qui a lieu dans les Pics." But the difference in the form and arrangement of the os hyoides and its muscles in the two animals will not sanction a comparison of their actions to an extent which would account for the phenomenon. In the woodpecker the cornua of the os hyoides are remarkably long and curved; they at first descend in the neck for some way; then turn up in a loose sheath over the occiput, and pass as far forwards as the upper mandibule, into a groove of which they enter. Muscles which arise from the chin, and follow the course of these cornua to their very points, have the power of retracting them, and in the same proportion of propelling the tongue, which is a solid continuation of them, out of the mouth. Whereas in the chameleon, whose tongue can be projected even farther than that of the woodpecker,

* Leçons d'Anatomie Comparée, T. 3. p. 273, 274.

† Ibid. T. 2. p. 681.

the cornua of the os hyoides are not so much as an inch long, and the space they have to move in is so limited, that the muscles extending from them to the lower jaw could not, by pulling them forwards, advance the tongue out of the mouth more than half an inch. Since then, the structure of the prehensile portion of the tongue will not admit of its elongation; and since also the point of the style cannot be advanced from the mouth more than half an inch, to which two circumstances alone the Baron attributes the protrusion of the organ, it is evident that his explanation is incomplete, inasmuch as it does not account for its usual propulsion to the distance of five, six, or seven inches.

Having thus passed under review the several theories advanced in explanation of this remarkable process, and shown their respective insufficiency to that end, I venture to offer one which to me appears not only unobjectionable, but adequate to account for all the phenomena: namely, that the projection of the chameleon's tongue is caused, partly by the advancement of the os hyoides, but chiefly by blood rushing into the numberless vessels of the organ distending, and elongating its erectile portion: and that its subsequent replacement in the mouth is effected by the retreat of the os hyoides and subsiding of the turgescence, aided by the contraction of the hyoglossi muscles.

The appearance of the tongue when protruded during life, its rigidity, its dark colour, and the turgid condition of its vessels, first suggested the idea of its being an erectile organ. The peculiarities of its organization discovered after death, its high vascularity, the remarkable size, course, and termination of its veins, and above all, the unique and beautiful provision near the heart to receive the sudden reflux of blood, gave it additional confirmation. And the experiment of imitating the natural process by filling the vessels

with quicksilver, though necessarily not as conclusive as might be desired, was nevertheless sufficiently so, in my opinion, to place the matter beyond a doubt.

An additional argument in favour of the supposition, that the chameleon's tongue undergoes in being protruded an erectile action, may be found in the influence which the state of warmth and vigour of the animals had on their projectile powers; for except about noon-day, and during the sunshine, or while the animals were near the fire, they could seldom be excited to attack a fly; any attempt, except under such circumstances, rarely being successful. I have several times seen one of them, when cold and sickly, make the effort. It opened its mouth, and advanced its tongue a short distance, about as far as the muscles going from the chin to the os hyoides might effect it, but could succeed little farther: the prehensile part either did not leave the style at all, or bent towards the ground, and fell short of its object. In this state of the animal the power of changing the colour of its skin was as imperfect as that of protruding its tongue; both failures perhaps alike resulting from the same cause, the languid state of the circulation.

If, by any cause, the chameleon were provoked to anger, of which it appeared very susceptible, its tongue, as well as its skin gave evidence of the same excitement; it swelled out prodigiously in the throat, so that had the style, which pressed forcibly against the integuments under the chin, been elevated, I have little doubt the organ would have undergone a partial elongation.

The effect on the animal of frequently protruding its tongue might also be advanced in support of the same theory. An interval of rest was always taken between the acts, which I have never seen repeated above six or eight times in succession; and even this was evidently followed by fatigue. Mere muscular action would not so

soon produce exhaustion: the tongue of the woodpecker, which is protruded solely by this cause, can be shot out many times in quick succession without the animal's evincing any subsequent fatigue.

When the mouth is shut and the tongue at rest, both its erectile and prehensile portions are drawn on the style, the point of which rests against the symphysis of the chin, close behind the front teeth. In this state the prehensile part surrounds the two anterior thirds of the style, and the erectile portion is folded in plaits on its posterior third (Fig. 7. E and H). When the tongue is about to be darted forth, the mouth opens just enough to give it passage, and the style, carrying with it both portions of the tongue, is protruded from the mouth for about half an inch, by the actions of the genio-hyoid, and three cerato-maxillary muscles. The progress of the os hyoides under the skin is visible, and so far it can advance the tongue, but no farther. The prehensile portion, unchanged in bulk, now flies off the style in the direction given it by that bone, and propelled by the erectile portion, which from being so small and pliable as to lie folded on the root of the style, acquires a length equal to the entire body of the animal, a thickness nearly as great as that of the prehensile portion, and a rigidity which enables it to advance in a straight line, carrying the latter before it. The stretching of the mucous membrane on the sides everts the edges of the pouch on its extremity, which is thereby expanded to cover the prey with more certainty.

The object of the propulsion of the tongue being attained, the mouth opens wider, partly to give more ready admission to the prey, and partly, perhaps, for the purpose of relaxing the muscles and favouring the return of the accumulated blood; the os hyoides is drawn back by the sterno-hyoid, sterno-ceratoid, and omo-hyoid muscles; the turgescence of the erectile part subsides; the pouch

on the end is again deepened by the action of the retractor muscles, and the relaxation of the mucous membrane on the sides; and the hyo-glossi draw in the tongue, folding up the erectile portion and replacing the prehensile on the style. The parts thus arranged, the organ is made fit for the ordinary purposes of mastication by the annular muscle fixing the prehensile portion, and preventing its rotation on the slippery style, and by the hyo-glossi drawing it in the direction of the cornua of the os hyoides, so as to obviate any displacement forwards.

The chief objection urged against this theory is the difficulty of conceiving how vascular congestion could effect the elongation with the rapidity ascribed to it during health. This objection, however, does not apply to the act as observed in those animals from which I have drawn my conclusions, for the motion of their tongues was by no means so rapid as to be irreconcileable with such a cause. It was not more rapid than the instantaneous blush on the cheek of youth; nor more rapid than several other phenomena which are universally allowed to be the result of vascular turgescence. How far in a state of nature the rapidity of projection exceeds what was observed in those weakened by confinement, I cannot determine; but perhaps the difference may not be so great as is usually believed. Few of our accounts on the subject have been given by naturalists on the testimony of their own observation; and it is not going too far to suppose, that it may have been with their descriptions of the chameleon's tongue, as with those given by them of its skin, in which fancy contributed so largely to the colouring: for we must admit, that much of imagination has mingled with their accounts of the organ, when we find it described, and even figured, as in the act of turning backwards and seizing objects placed on its tail, a range

of motion by no means compatible with its structure or cause of action.

I have already observed—and it may partly account for the reputed quickness of the tongue—that at one period of the elongation the rapidity, even in my chameleons, was such as might justly be compared with that of an arrow, but then it was only momentary, and observed during a very short stage of the process. The progress of the tongue on leaving the mouth was at first slow, and became gradually accelerated as it approached near the prey, when it shot forwards with remarkable quickness—a mode of proceeding much more likely to ensure success than if it had advanced with uniform rapidity from the commencement. This quickness perhaps equalled that which is attributed to the organ when in vigour; but it was only manifested after its gradual repletion with blood, and when a slight impulse was sufficient to produce it.

Should the explanation which I have given of the mechanism of the chameleon's tongue, founded on its structure and appearance during life, be admitted as applicable to the animals on which I have made my observations, it may be likewise to all, however vigorous, for the same cause must equally produce the elongation whether the act be rapid or slow—whether it take place during a state of activity or weakness.

Several individuals who have witnessed the change of colour and mode of feeding of my chameleons, can corroborate the accuracy of the above statements; but I shall particularly refer for evidence of

it to my friend Mr. Tagert, who took a particular interest in observing their habits; and who, even while the animals were alive, agreed with me in the opinion, which I hope my after dissections have sufficiently established, regarding the cause of elongation of the tongue.

Most of the preparations from which the drawings were taken I have preserved, and placed in the Museum of the Royal College of Surgeons.

YORK-STREET.

EXPLANATION OF THE PLATE.

Fig. 1*st.*—*The Os Hyoides.*

A The style.
BB The anterior cornua and cartilaginous pully.
CC The posterior cornua.
hhh The internal cerato-maxillary muscle.

Fig. 2*d.*—*The Muscles.*

C The posterior cornua of the os hyoides.
D Lower jaw.
a Sterno-hyoid.
b Sterno-ceratoid.
c Omo-hyoid.
d Internal genio-hyoid.
e External genio-hyoid.
f External cerato-maxillary.
g Middle cerato-maxillary.
h Internal cerato-maxillary.
w Internal jugular vein.
y Carotid artery.
z Lingual artery.
E Prehensile portion of the tongue appearing in the mouth.
H Plaited condition of the erectile portion.

Fig. 3*d.*—*Superior surface of the tongue as seen when protruded at the will of the animal.*

E Prehensile portion.
F The pouch.

G Mucous gland.
H Erectile portion.
K Upper jaw.
nn Vessels of the tongue.

Fig. 4th.—View of the tongue as it appears when drawn from the mouth after death.

A The style.
BB Anterior cornua.
CC Posterior cornua.
E Prehensile portion.
F The pouch.
G Mucous gland.
H Erectile portion.
iiii Hyo-glossi muscles.
nn Vessels as seen in the erectile portion without injection.

Fig. 5th.—Dissection of the prehensile and erectile portions.

kkk Investing membrane and vascular tissue laid open.
F The pouch
ll Retractor muscles of pouch.
m Under surface of mucous gland.
nn Vessels of the erectile portion, some containing quicksilver.
oo The annular muscle which surrounds the tube, laid open on one side to show
pp The tube.

Fig. 6th.—Dissection of the Heart and Vessels.

A The style.
ii Hyo-glossi muscles.

h Internal cerato maxillary muscle.
L The trachea.
r Thyroid gland.
M Membranous bag at top of larynx.
N Lungs.
O Liver.
s Ventricle of heart.
tt Right and left auricles.
uu Aorta.
v Great venous dilatation.
w Internal jugular vein.
x Lingual vein of right side.
y Carotid artery.
z Lingual artery.

Fig. 7th.—This figure is intended to explain the manner in which I conceive the prehensile and erectile portions are fitted on the style when in the mouth.

E The prehensile portion.
H The erectile portion thrown into plaits, some of which lie round the style, others overlap the back part of the prehensile portion.

Fig. 8th.—M. De la Hire's drawing of the elastic tendons, &c.

BABA The tendons by which the tongue is kept in a state of constant elongation.
CC The longitudinal muscle by which it is retracted.

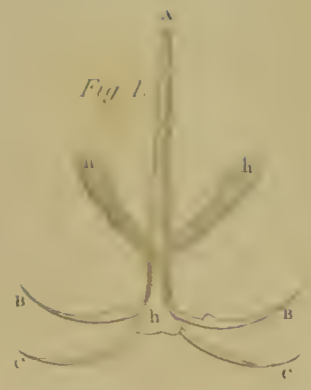
Fig. 1.
A
a
h
B
h
B
C
C

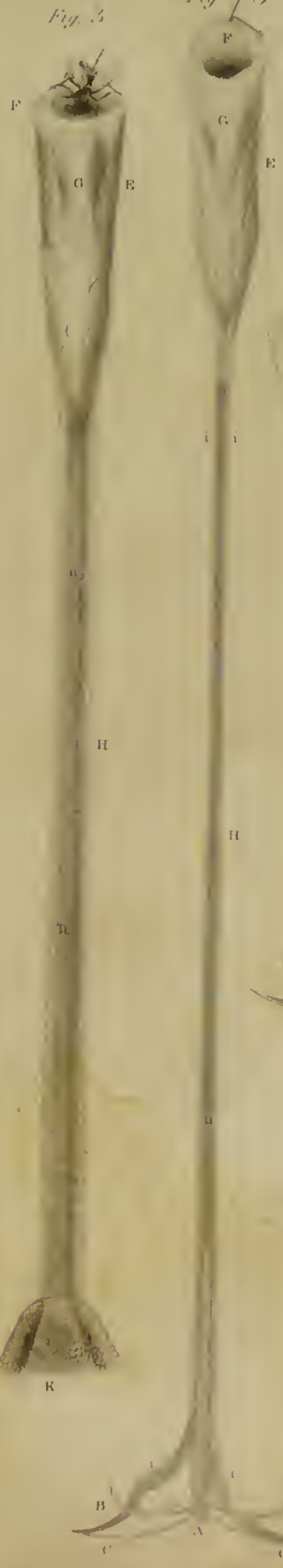
Fig. 3.
F
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E
K
Fig. 4.
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C
C


Fig. 2.
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C
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b
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Fig. 5.
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k
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n
k
P
k


Fig. 7.
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E
H


Fig. 6.
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L
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N
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Fig. 8.
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B
C
A